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OPTIMIZATION OF RUBBER PRODUCTION MANAGEMENT: CASE OF SAFACAM

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ABSTRACT

The work presented here concerns the optimization of production management at SAFACAM in the rubber factory. To minimize unproductive time and avoid misuse of resources by improving profitability we have set ourselves the goal of reducing production losses on the production line and setting up a production management method for better monitoring of material consumption, propose a way to optimize production times. To do this we first made an inventory of fixtures of the production management system through the survey sheets that we had established to identify the deviations from the standards, the evaluation of these records. The survey was done using the Kiviat diagram, allowing us to focus our work on production losses, material consumption monitoring, information flow management, personnel management and management maintenance. We have established a production management procedure to solve the problem of production losses, then we have suggested and led the implementation of the MRPII method based on the calculation of needs for the monitoring of the production and consumption of materials. Estimated gains on non-production are valued at 48965.42 USD

KEYWORDS: Optimization, Production management, Rubber, Requirements planning

I. INTRODUCTION

Hevea is the vernacular name of the tree (Hevea brasiliensis), of the genus Hevea, whose sap, called latex, is used to be transformed into rubber. The rubber tree is a large tree 30 to 40 meters high, whose trunk can reach 1.5 m in diameter near the ground. Its fruit is a tricoque capsule. Today, rubber is almost the only source of natural rubber, an irreplaceable product for the tire industry or the manufacture of latex condoms and gloves. From a chemical point of view, the natural rubber is a cis polyisoprene 1-4, [C5H8] n, where " n " is a natural integer ranging from 14.103 to 22.103; its molar mass in turn varies from 1.106 to 15.106 g / mol. The sap of the rubber tree, the latex, is harvested by doing what is called spiral bleeding, at the first light of day; the flow lasts 4 to 5 hours. A shallow deep incision is made in the tree at a height of at least 1.50 meters. There are three varieties of rubber machining: the Ribbed Smoked Sheet (RSS), the granulated rubber from the latex and the secondary quality granulated rubber (from the field cups).

Speaking of the management of production, it is necessary to give some necessary definitions. Thus, **production** is the transformation of resources (human or material) for the creation of goods or services [1]. The **production function** : consists in producing, in due time, the quantities requested by the customer under cost and quality conditions determined by optimizing the resources of the company so as to ensure its durability, its development and its competitiveness. To **manage** is to plan, execute, control well-defined activities [2]. **Production management** is the search for an efficient organization of the production of goods and services. It aims to synchronize all the production actions acting on a flow of material that cross the company, taking into account constraints and performance criteria, from physical, human and financial resources [1]. It is also a function to organize and regulate the flow of materials and products throughout the processing cycle from the order of the raw materials to the delivery of the finished product [3]. These are all the activities involved in: designing, planning resources (material, financial or human), scheduling, recording production activities, controlling the production activities of the business. All of these activities must be carried out in accordance with established procedures (implicitly or explicitly) by the company taking into account both the quality of its products or services, but also the safety of its employees or its employees. environment. The organization of the production differs according to the companies, their environment, the customers, the suppliers and the products. But the goal is similar, it is to produce while trying to get closer to the 5 zeros (zero stock, zero defect, zero paper, zero failure, zero delay). Managing production, [1] is about: the product itself, the manufacturing processes, the organization of production, manufacturing costs, the quality of products, deadlines, the demand for products customers, the necessary staff, the infrastructure, the supply of raw materials.

Production management focuses on flows: physical flows : supply, input and circulation of raw materials, components, spare parts, finished products, information flows : order tracking, OF (order of manufacture), followed by technical data (nomenclatures, production lines ...), consumption of raw materials, hours of labor, scrap. The main concern of production management is customer satisfaction, so it must: seek to control physical flows, by eliminating operations that do not generate marketable values, qualify and accelerate physical flows by avoiding breakdowns, by reducing the time required change of series, controlling the external transport flows of the product, create a coherent and relevant information and production management system.

Located at the crossroads of contradictory objectives, management is a cross-functional function, that is to say, what is related to most other functions and most of the information systems of the company. The figure below clearly illustrates this topic.

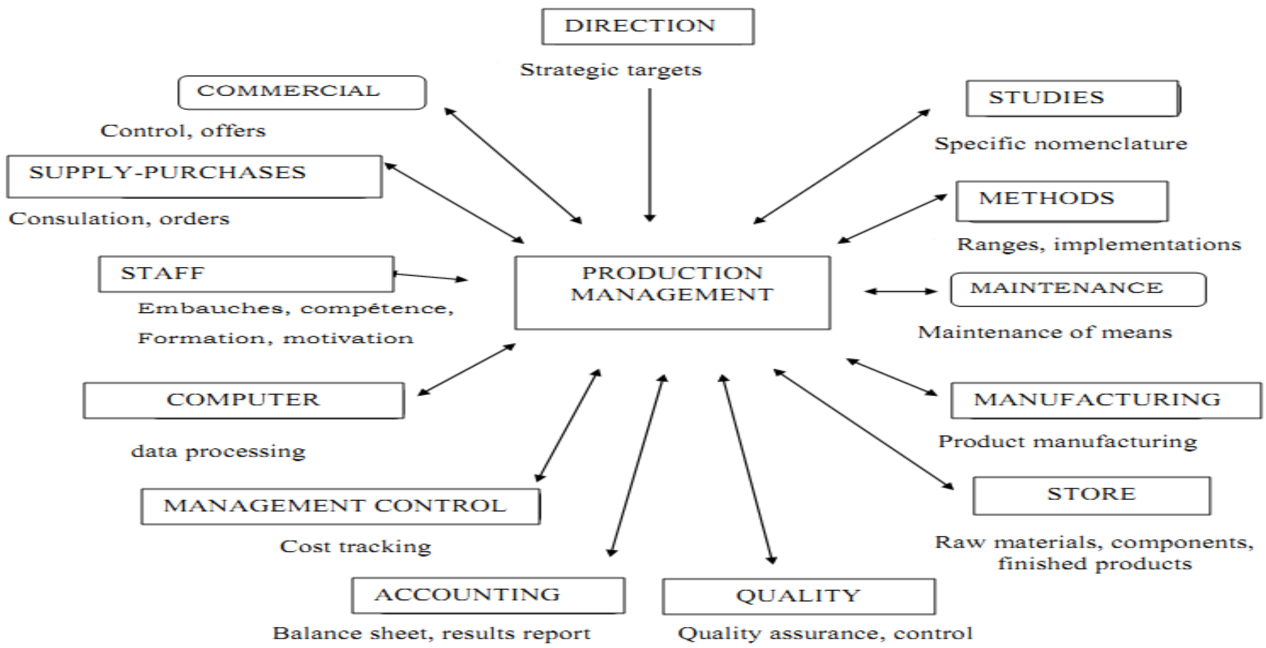

Figure 1: Place of production management in a company

There are four stages of production management, described as follows: **technical data management**, which consists of highlighting the technical data relating to production, as well as their detailed description, namely: products and product families (nomenclatures) and the realization processes (ranges); the **commercial data management which manages data** in connection with the order of the customer by the sales manager. This includes receiving orders from customers and establishing desired delivery schedules ; **material management** which consists in ensuring the availability of the raw material for production and for this it must : ensure the supply of raw materials or components and ensure the storage of manufactured products and **work management** which consists in organizing the realization of tasks in time by allocating them the necessary resources. It takes into account the technical and commercial data and those of the manufacturing follow-up (quantities already manufactured, state of the resources.

Several production methods stand out in the literature, including: the MRP method which is subdivided into two: the "**Material Requirements Planning" (MRP I)** which is a computerized method of production planning and inventory control in view to manage industrial production. This method can be implemented without computing and is based primarily on the calculation of needs [4]. **Manufacturing Requirements**

Planning (MRP II) is a production management method that allows knowing the average time spent by articles on each production resource as well as product structure, to forecast launches of various orders. in order to ensure that everything is available, without advance and without delay, at the right time [4]. To do this, it is necessary to take into consideration: the **independent needs** (customer orders for finished products and subassemblies or spare parts); these needs can be predicted and should be estimated and the dependent needs (generated by **independent needs**) that can and should be calculated; this calculation can be done by knowing the structure of the articles (finished products, subassemblies, components and materials) and the time required for their production. Independent requirements are usually managed by a control point strategy while dependent needs are taken into account by a needs calculation. The MRP II method is used by many organizations as a tool to limit, anticipate and solve these problems. Thus the questions that MRP II proposes to answer are the following: [3] Which article is necessary? How much do I need? When will I need it? The implementation of the MRP II method goes through several stages, ranging from the strategic level of decisions to the hierarchical and operational level [5]. The diagram below shows the different levels of the MRP II method.

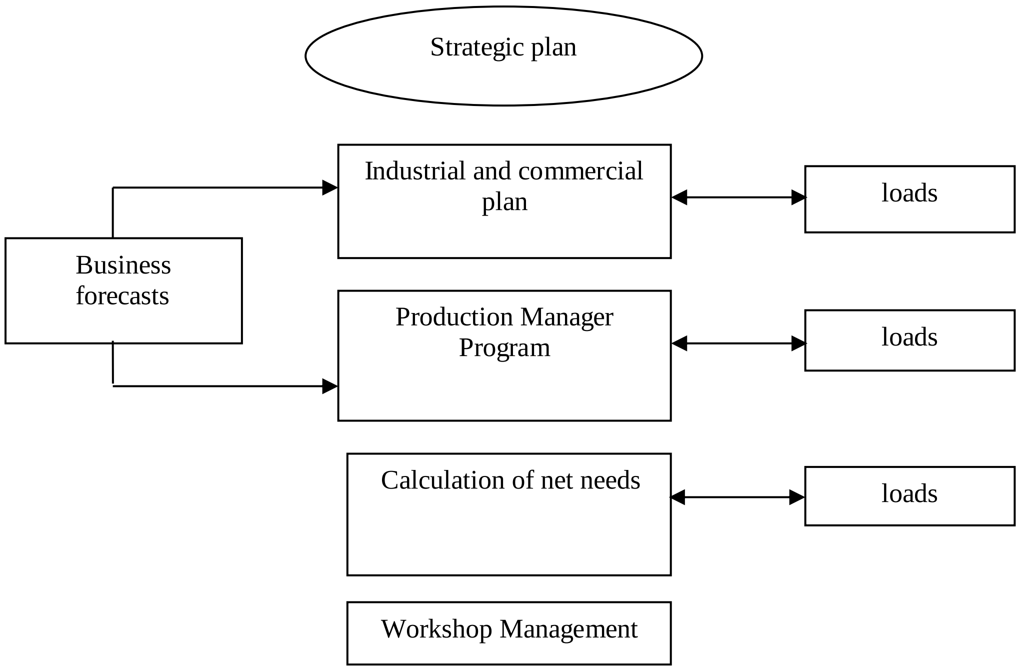

Figure 2: Establishment of an MRP II

The Commercial Industrial Plan here is a stage in which sales agents give the production estimates while taking into account both types of needs (dependent and independent needs), which serves as a forecast for the management and monitoring of production. The production program, which is established from the Commercial Industrial Plan and the commercial forecasts, then begins directly the calculation of the net needs. From the Production Program, the product nomenclature is exploded and the net requirements are calculated. So out of this calculation we have messages that correspond to proposed orders (order launch, or purchase recommandation). Other methods of production management include: the **Marking out**: which is a method of production management that consists of staggering and to mark over time of the successive operations planned in the manufacturing and assembly lines; the **scheduling**: which is a production management method that allows to start the manufacturing on demand expressed upstream in terms of specifications, quantities, dates aiming to optimize the use of resources on time; the **management of Stocks**: which is a method or tool of production management consisting in calculating the necessary fair in quantity of pieces for the good operation of the workshop, the company, the **KANBAN** method: which is a method or a tool production management and workshop management (Can be used to meet just-in-time objectives) and the **SMED** method or "Single Minute Exchange of Die" tool which aims to reduce series changeover times .

II. METHOD

Inventory of fixtures of the production system: which consists here in highlighting the production management system as it stands, in order to identify strengths and weaknesses in order to intervene. It will therefore be a question of first highlighting the **Investigations sheets** , which are well developed forms and intended initially for the managers of the various departments and sections of production, then the operators, allowing them to make their own judgment on the production management system, and thus evaluate the production management system and then make an analysis by the Kiviat diagram, which will consist in targeting the sectors whose state is considered critical in order to provide solutions.

Analysis of production hours: It will be a question of carefully examining the planned downtime in a simple way. Then we rely on the TRS (synthetic rate of return) approach. The TRS approach aims to identify the main causes of loss of productivity and to define the axes of progress with a view to achieving the optimum expected performance of the equipment. We will therefore focus on the characteristic times of the production line. To achieve this, it is necessary first of all a collection of the data, then a processing of the data leading to the calculation of the MTBF (average of the good times of operation) [6] and then a definition of the indicators [7]. To observe the performance of the plant, four indicators are to be introduced: the synthetic rate of return (TRS), the coefficient of use (CU), the coefficient of performance (COP) and the coefficient of reliability (CF). We pose:

$$\text{Useful time (h)} = \frac{\text{Quantity produced}}{\text{Nominal capacity}} \times 100 \quad (1)$$

$$\text{TRS}(\%) = \frac{\text{Useful time}}{\text{Opening time}} \times 100 \quad (2)$$

$$\text{CU}(\%) = \frac{\text{Operating time}}{\text{Opening time}} \times 100 \quad (3)$$

$$\text{CF}(\%) = \frac{\text{Operating time}}{\text{Operating time} + \text{Stop time on accident}} \times 100 \quad (4)$$

$$\text{COP}(\%) = \frac{\text{Useful time}}{\text{Operating temp}} \times 100 \quad (5)$$

The TRS is chosen to have a global vision of the output of the means of production. The other three (the CU, the CF and the COP) draw attention from the experience they have within the Lafarge group, one of the leading groups in building materials. Lafarge Group's targets are: 93% for CU, 97% for C0P and 98% for CF [8]. The following abbreviations are adopted: TO for the opening time, TF for the operating time, TU for the useful time, CN for the nominal capacity.

Production management method used: MRP II remains on the calculation of needs and starts with the collection of information necessary for effective management; for this answer first to the question « What production will be needed in the next period of time? » Which brings us to highlight, the articles and the nomenclature of the products. The second phase is the calculation of the time required for this production as well as the list of necessary components, hence the place of the production cycle, followed by the industrial and commercial plan and ending with the calculation of net requirements.

III. RESULTS

Inventory of fixtures

- **Investigation sheets**

These are well-developed fact sheets, initially intended for the managers of the various departments and production sections, and then for the operators, enabling them to express their own judgment on the production management system, and evaluate the production management system. They consist of 6 modules each having 5 questions, and the assessment is made on a quota of 10 (see table below).

Tableau 1 : Investigations sheets

Information flow management		Inventory Management and Supplies		Quality management	
A. Is there a communication plan within the plant?		**A. Is there inventory management monitoring within the plant?**		**A. Is there a monitoring of the quality of raw materials and finished products?**	
0	There is no plan	0	Follow-up does not exist	0	Follow-up does not exist
1	There is a plan but not followed by al	1	Monitoring exists but is not under control	1	Monitoring exists but is not under control
2	There is a well-followed plan	2	Tracking exists and is updated	2	Monitoring exists and is under control
B. What is the nature of relationships with other ID services?		**B. What is the frequency of machining stops caused by the lack of raw materials?**		**B. Is each position well established?**	
0	Stretched	0	Regular	0	There is no job definition
1	Harmonious, but there are some misunderstandings	1	Average	1	Some posts have a definition
2	Perfect	2	Almost zero	2	Most positions have a definition
C. What is the nature of relations with the hierarchy?		**C. How long is the machining stop due to the lack of materials (raw materials and / or spare parts) evaluated?**		**C. Are the operators working there well trained?**	
0	Stretched	0	More than a week	0	Are not qualified
1	Harmonious, but there are some misunderstandings	1	Less than a week	1	Are moderately qualified
2	Perfect	2	Few hours (less than a day)	2	Are well qualified
D. What is the nature of relations with other directions?		**D. Is the plant permanently supplied with raw materials?**		**D. Does the long shelf life of the finished product affect its quality?**	
0	Stretched	0	Stockouts are common	0	Verry much
1	Harmonious, but there are some misunderstandings	1	The percentage of supply is 30 %	1	Moderately
2	Perfect	2	Inventory movements are well controlled	2	Almost negligible
E. What is the level of information exchange between different teams?		**E. What is the frequency of machining stoppage due to out of stock of spare parts?**		**E. Is the finished product always of good quality?**	
0	Very low	0	Very regular	0	Almost not
1	Medium	1	Average	1	Most of the time
2	Very good	2	Almost zero	2	Always

Maintenance management		Staff management		Monitoring of material consumption	
A.Is there a maintenance plan for plant equipment?		**A. Is there a fixed organization chart of the plant?**		**A. Is there a production master plan?**	
0	The maintenance plan is not available	0	The organization chart is not available	0	The plan is not available
1	The maintenance plan is incomplete and / or out of date	1	The organization chart is incomplete and / or out of date	1	The plan is incomplete and / or not up to date
2	The maintenance plan is complete	2	The organization chart is complete and up-to-date	2	The plan is complete and up to date
B. How long is the plant downtime for maintenance during machining?		**B. Is each position well established?**		**B. Is each production sector well under control?**	
0	Too long	0	There is no job definition	0	There is no definition of the production sector
1	Medium	1	Some posts have a definition	1	Some sectors have a definition
2	Negligible	2	Most positions have a definition	2	Most sectors have a definition
C. What is the operating level of CMMS software?		**C. Is there a training / recycling policy for operators?**		**C. Is tonnage monitoring (FDT and balls) well under control?**	
0	The software is not operated	0	There is no training / recycling policy	0	There is no tonnage tracking
1	The software is operated at 15%	1	A policy is defined, but not respected	1	Follow-up is defined but not respected
2	The software is well exploited	2	A policy is well defined and implemented	2	Follow-up is well defined and implemented
D. Is there a plant shutdown schedule for maintenance?		**D. What is the motivation level of the operators?**		**D. Are there any losses in raw materials?**	
0	There is no planning	0	There are no motivated employee	0	Too important
1	The stops are done, but do not respect any schedule	1	The motivation percentage is 15%	1	Less important
2	The schedule exists and is well respected	2	Employees are very motivated	2	Negligible
E. What types of maintenance are applied at the factory?		**E. What is the number of skilled operators per machine?**		**E. Are there any losses throughout the manufacturing process?**	
0	Corrective only	0	There is no qualified machinist	0	Too important
1	Preventive uniquement	1	There is at least one team qualifier	1	Less important
2	Corrective et preventive	2	All are qualified	2	Negligible

We have: the personnel management module, the material consumption monitoring module, the inventory and supply management module, the maintenance management module, the information flow management module and the quality management module. Interviews and surveys conducted with the factory head and team leaders allowed us to obtain the results presented below.

Tableau 2 : Survey results

Modules	**Note**	**coef**	**Note×coef**
Maintenance management	5	1	5
Staff management	4	0,5	2
Monitoring of material consumption	8	1	8
Information flow management	5	0,5	2 ,5
Inventory Management and Supplies	8	1	8
Quality management	6	1	6

- **Kiviat Diagramme**

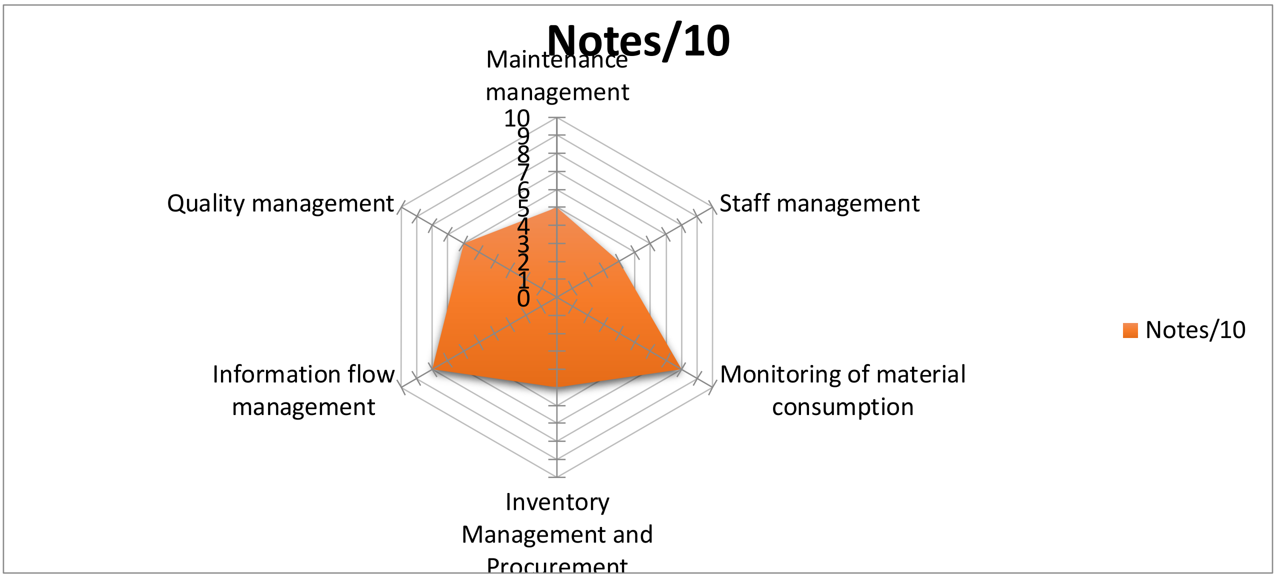

Figure 3: KIviat Diagram

The Kiviat diagram above, enabled us from the evaluation of Investigations sheets to choose the axes on which we will focus our work. The choice of these axes was based on the expert values given by the company, that is to say the axes that have a greater margin of progress to achieve. So we have: Quality Management, Maintenance Management, Personnel Management and Information Flow Management.

Analysis of hours related to production

The production line accumulated 7272 hours (or about 303 days) of opening for a production of 4726,575 tons of rubber.

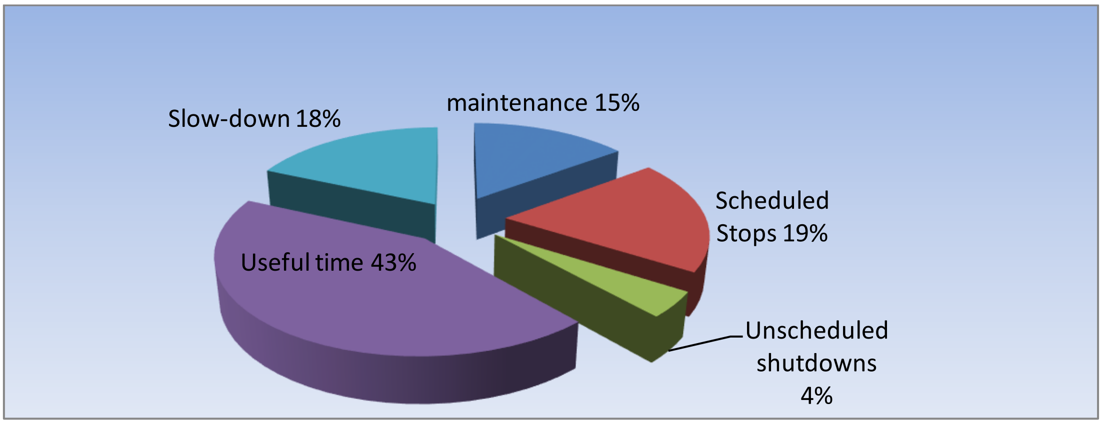

Figure 4: **Time allocation on the production line**

Figure 4 tells us that the useful time for this production is 3151 hours and 3 minutes, or about 43% of the total time. The slowdown engulfs 1335 hours and 56 minutes, or about 19% of the total time. The time of scheduled stops for maintenance 1078 h, about 15% of the total time. As for the stops themselves, the scheduled stops arrive at the top with 1396 hours and 54 minutes (about 19% of the total time), and stops on incidents or unscheduled 311 hours and 36 minutes, or about 4% of the total time.

- **The scheduled downtimes**

The nominal production capacity of the plant is estimated at about 1.5 t / h. The analysis of the causes and impacts of the planned downtime brings to light two types of scheduled shutdowns, namely: the economic downtime and planned outages of the production master program (PDP) as shown in Figure 5:

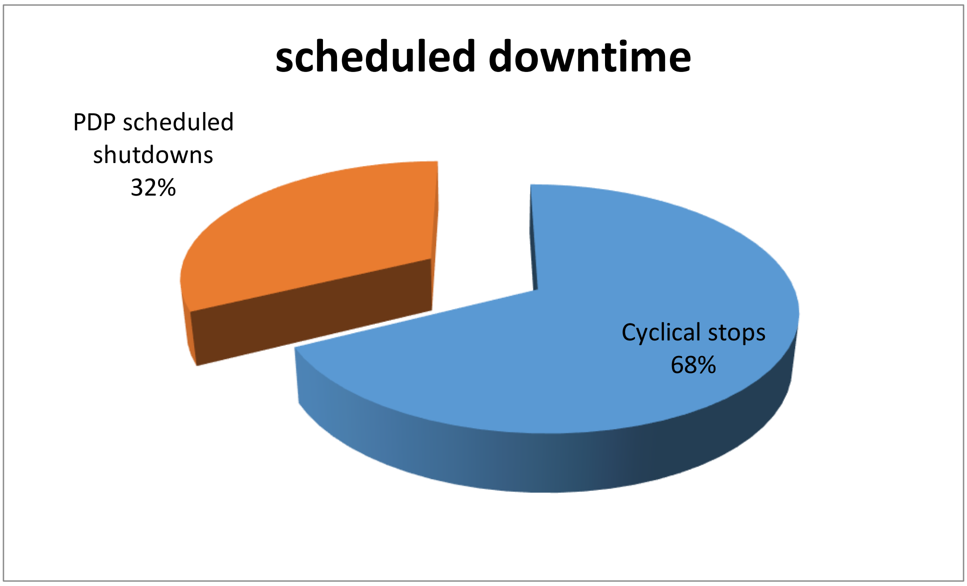

Figure 5: Downtime programmed according to the production master plan

We can see in Figure 5 that economic downtime accounts for 68% of scheduled downtime, while planned outages of the master program are 32% of scheduled downtime. It should be noted here that during scheduled outages the company carries out maintenance (cleaning, maintenance of equipment, etc.) and is obliged to pay staff. The company's revenue shortfall is estimated at 28,350 tons or 48 747.83 USD for the period from September 2017 to August 2018.

- **Unscheduled downtimes**

To observe the performance of the line, we will use the three indicators that are the Coefficient of Use (CU), the Coefficient of Performance (COP) and the Coefficient of Reliability (CF).

Tableau 3: Main time and value of the indicators on the production line

Wording	Value
Rated Cadence	1 ,5 t / h
Quantity produced	4726,575 t
Opening time (TO)	7272h
Operating time (TF)	4487,00h
Useful time (TU)	3151,06h
Stopping time on incident (TAI)	311,00h
Coefficient of use (CU)	**61,70%**
Coefficient of Relability (CF)	**93,52%**
Coefficient of Performance (C0P)	**70,23%**
Synthetic yield percentage (TRS)	**43,33%**

Table 3 summarizes the main times on the production chain that make it possible to calculate the indicators. With a TO of 7272 h, a TF of 4487.00 h, a TU equal to 3151.06 h and a TAI of 311.00 h, 61.70% is obtained for CU, 93.52% for CF, 70.23% for the COP, and a TRS equal to 43.33%.

- **Impact on the performance of the production line**

Figure 6 shows that the number of incident stops per month varies between 4 in September 2017 and 17 in October 2018. There are also second peaks in November 2017 and December 2017 (11 and 10 incidents). Between January and August 2018, the number of incidental stops is concentrated between 6 and 9.

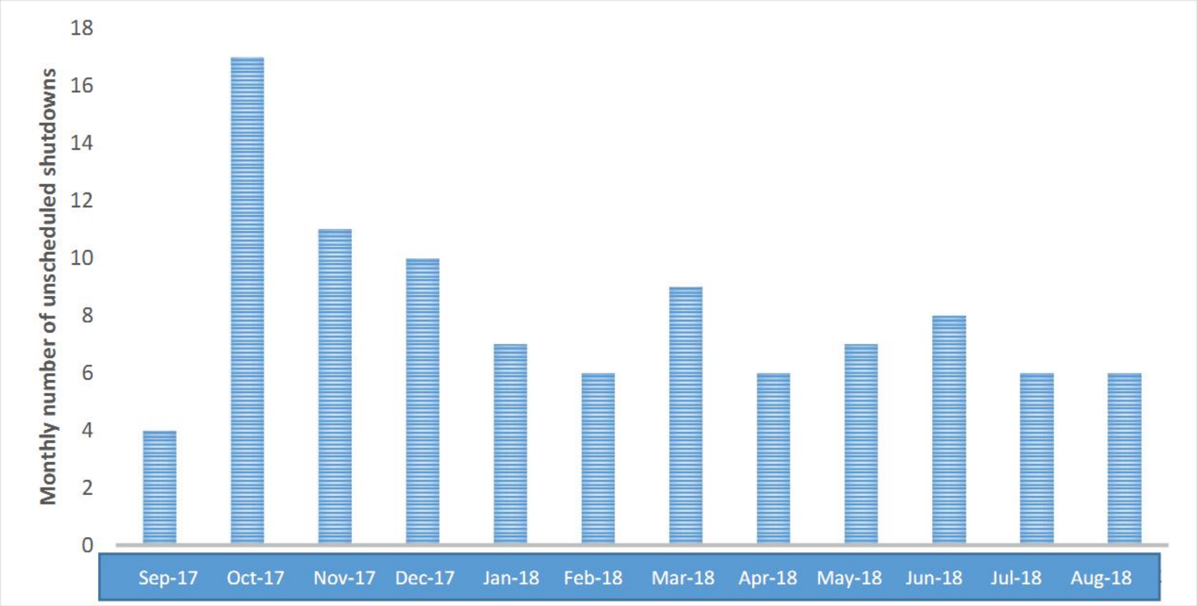

Figure 6: Number of Monthly Incident Stops on the Production Line

Figure 7 below shows the monthly change in the time (in hours) of incidents. It ranges from 5.76 hours in July 2018 to 49.83 hours in December 2017, with four peaks in October 2017 (41.15 hours), November 2017 (41.98 hours), and February 2018 (44.41 hours).) and in March 2018 (41.71 h). In September 2017 (9.41 hours), January 2018 (11.43 hours) in April 2018 (14.71 hours), and in May 2018 (15.41 hours), the number of incidents was low.

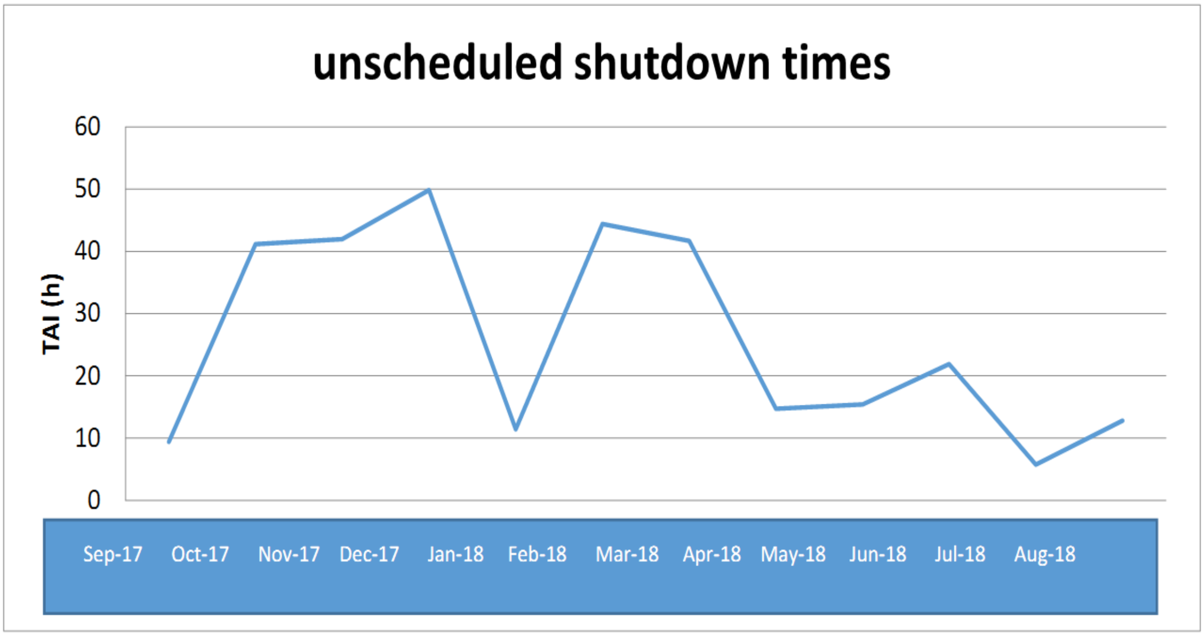

Figure 7: Time of unscheduled stops

Tableau 4 : MTBF and MDT values

Wording	Value
Average Time of Good Operation (MTBF)	**46,25h**
Average Time to Service (MDT)	**3,2h**

Implementation of the method MRP II

- **Articles**

Tableau 5 : List of articles

Products	characteristics of the Customers			
	initial plasticity P_0 (index of retention)	**PRI**	**ML (1+4)** Viscosity Mooney	**%Dirt** Content of Impurities
Standard	$37 \geq Po \geq 43$	≥ 65	≥ 70	$\leq 0{,}06$
Michelin	≥ 37	≥ 50	≥ 70	$\leq 0{,}07$
Nokian	≥ 30	≥ 50	/	$\leq 0{,}08$
Special standard	depends on the customer	depends on the customer	depends on the customer	depends on the customer

- **Product nomenclature**

The production of raw rubber depends on several parameters: cup bottoms, pulverized lime, the type of customer and the type of loading that determines the packaging method (loose or pallet). Raw rubber (finished product) is obtained by assembling between the product taken out of the oven (bottom of cup plus quicklime) and the coating (packaging). A more visual representation of the nomenclature is given in the form of a tree shown in Figure 8 :

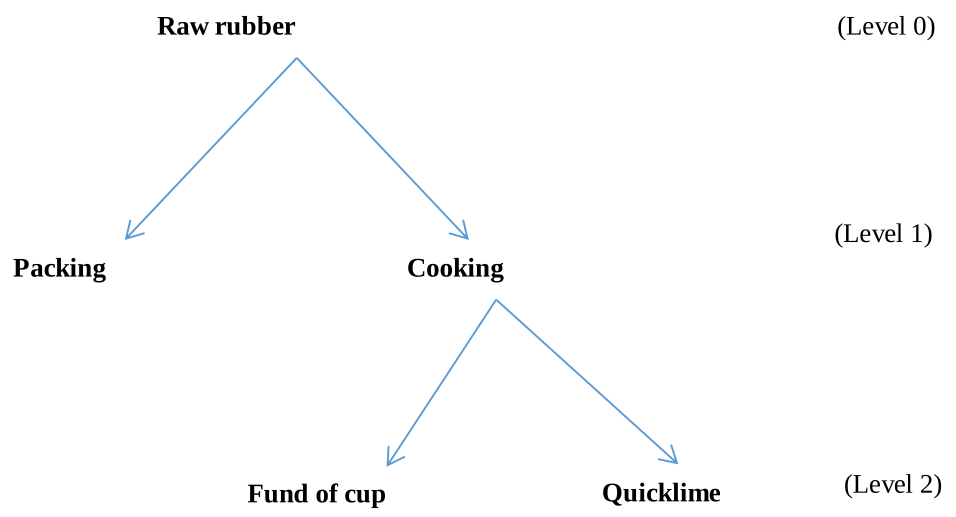

Figure 8: Nomenclature of the production process of Raw Rubber

- **Production Cycle and Production Range**

Once you have mastered the quantity of material, it is good to know the different steps and tasks for the production of a given article as well as the time it takes. The table below gives us the range of manufacture of an article as well as the production cycle.

Tableau 6: **Range of manufacture of an article**

Task	Entitled	Duration (min)	Ressources	Previous task	Observations	Average time
T1	Cutting coagulum		O		Requires a lot of physical effort	120 min
T2	Washing + cutting		M	T1	Depends on the capacity of the machines	15 min
T3	Filling basket		M	T2	Depends on the flow sent by T2 operations	24 min
T4	baking		F	T3	Hard to control because of temperature	240 min
T5	Weighing + pressing + packing		O+M	T4	Physical effort and depends on machines	48 min

The manual cutting time of the coagulas is so considerable that an automatic cutting device must be provided.

- **Industrial and commercial plan**

Tableau 7 : **Industrial and commercial plan**

Sale	J	F	M	A	M	J	J	A	S	O	N	D
Envisaged	486,3	355,3	289,8	289,8	355,3	269,6	355,3	516,6	315,0	315,0	214,2	214,2
Real	355,3	355,30	355,3	355,3	355,3	269,6	355,3	315,0				
Variation	-131	0	66	66	-66	0	0	-202				
Variation (%)	-27	0	23	23	-18	0	0	-39				

Production	J	F	M	A	M	J	J	A	S	O	N	D
Raw material	820,2	581,8	378,9	416,6	577,3	766,7	1112,9	865,4	900,3	779,4	997,8	801,2
DRC precedent	51,6	55,6	56,9	53,9	55,1	53,1	52,2	50,1	49,3	46,9	47,7	51,4
Envisaged	423,7	323,6	215,7	224,9	318,2	407,6	581,7	433,7	444,5	366,1	476,5	411,8
Real	459,2	339,7	203,1	234,1	315,1	398,3	583,6	444,5				
Variation	35	19	-13	9	-3	-9	2	11				
Variation (%)	8	5	-6	4	-1	-2	0	2				

Stock	J	F	M	A	M	J	J	A	S	O	N	D
Envisaged	315	315	214,2	214,2	355,3	214,2	214,2	214,2	214,2	214,2	214,2	214,2
Real	318	302,5	150,3	29,1	54,5	183,2	411,5	541,1				
Variation	3	-12	-64	-185	-160	-31	197	327				
% of objective	1	1	1	0	0	1	2	3				

Given the indicators: -39% for the sale, 2% for the production and 3% of the target stock. The examination of the past eight months shows that the commercial service did not reach its forecasts and that production exceeded them. The stock is currently above the expected range. The PIC meeting is here to decide which policy to choose. With planned sales, the stock level will quickly fall back towards the goal.

- **Calculation of net needs**

Ce calcul prend en compte le délai, le stock prévisionnel, le stock de sécurité, la notion de taille du lot et se fait

This calculation takes into account the delay, the forecast stock, the security stock, the notion of lot size and is based on certain well-defined information in a conventional way. For a product we have the following conventions: i = Index of the period considered, BBi = Gross Requirement for period i, Spi = Forecasted Stock for period i, Si = Stock at the end of period i, OL = Order Launched SS = Security Stock Del = Product

Delivery Time TL = Lot Size BNi = Net Requirement for Period i OP = Proposed Order; D = Start; F = End, SP (i) = S (i-1) - SS + OL (i) -BB (i). If SP (i) <0, BNi = 0 and if SP (i)> 0, BN (i) = BB (i) - SP (i).

Tableau 8 : Need in FDT

Time limit: 1 mois | % of lost: 5% | Batcht : | Ss :00

Article : FDT		1	2	3	4	5	6
BB		820,200	581,860	378,940	416,680	577,320	766,720
SP		0	0	0	0	0	
OP	F						
	D						
Start cupboard order 1 month before							

IV. CONCLUSIONS

In the end, the work done at SAFACAM focused on optimizing the management of rubber production. To carry out our project, we first made an inventory of the production management system of the company, where we identified the weak points namely: maintenance management, quality management, personnel management and information flow management. Thus we have deployed actions to optimize production management on the production chain through actions to be carried out. Then, we established a procedure for the management of the production this to reduce the losses of productions which after application could allow to recuperate close to 68% of the programmed downtimes. That is a saving of 48965.42 USD for the twelve months we examined by developing a good policy of acquisition of the raw material, and in terms of maintenance, we found that we could gain 4.25% of the time stops if we manage to control the equipment priority. On the other hand, we have implemented MRP II method based on the calculation of the needs to manage the production by having a look at the consumptions of materials which will replace the methods applied previously. We can say that our goals have been achieved. But much remains to be done, however, as a perspective, always with a view to optimizing production, it will be necessary: to undertake the purchase of village bottoms to reduce the economic downtime; increase the number of compartments for a great conservation of the raw material.

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